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ABSTRACT

The purpose of this investigation was to test two hypotheses concerning the ability of taxonomic tests of cognitive processes to differentiate the performance of students from varying educational environments in an effort to shed additional light on the construct validity of Bloom's Taxonomy. (Author)

VALIDITY OF TESTS OF THE COGNITIVE PROCESSES

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Although considerable research has focused on the assumptions underlying the Taxonomy of Educational Objectives: Cognitive Domain (Bloom, 1956), little evidence is available concerning its measured relationships with other relevant, continuous or categorical variables (Cox & Unks, 1967; Kropp, Stoker, & Bashaw, 1966; Cox & Wildemann, 1970). The purpose of this investigation was to test two hypotheses concerning the ability of taxonomic tests of the cognitive processes to differentiate the performance of students from varying educational environments in an effort to shead additional light on the construct validity of the Taxonomy.

Consistent with the cumulative and hierarchical assumptions of the Taxonomy, I. L. Smith (1970b) demonstrated that intellectual but not creative ability is related to performance on the Knowledge, Comprehension, Application, and Analysis subtests, while intelligence plus creativity are related to the Synthesis and Evaluation categories. The results appear to support the conceptualization of tests of the first four and last two levels of the Taxonomy in terms of convergent and divergent processes, respectively. See Bloom, Hastings, & Madaus (1971) and I. L. Smith (1970a, 1971) for a further discussion of these terms in relation to the Taxonomy. Based on these findings and definitions, it would appear that performance on cognitive process tests derived from the Taxonomy should be sensitive to differences in school environments. Specifically, it is hypothesized that performance on the Knowledge, Comprehension, Application, and Analysis subtests favors students

attending a conventional-traditional school emphasizing convergent processes, while tests of the upper two levels favors those from a more open, spontaneous climate. In examining the two hypotheses, the possibility of sex, grade, and classroom differences were also considered.

Method

The two schools selected for study were intended to reflect maximum differences in educational environments (see Table 1).

INSERT TABLE 1 ABOUT HERE

School A, defined as the open, spontaneous (OS) educational environment, is a private school designed for the education of the academically talented. Admission requirements include high scores on a standardized test administered by the school and a score of at least 130 on the Wechsler Intelligence Scale for Children (WISC). There was some question as to whether the latter criterion was actually met in most cases. The WISC scores obtained by the school's headmaster bore little relationship to scores on the Lorge-Thorndike Intelligence Test, Level G, Form 1, collected during the course of the study (r=.40). In addition, the students averaged approximately 10 IQ points less on the Lorge-Thorndike. It would appear that the determination of WISC scores by the headmaster may have been spuriously high and/or a reflection of factors other than those related to intelligence.

School B, designated as the conventional-traditional (CT) educational environment, is a public senior high school located in a working class suburb. Most subject-matter areas are offered at four different track levels. Tracks

one and two are for the average and below average students, while tracks three and four are sections for the college bound.

The sample consisted of 20 randomly selected students (10 male, 10 female) from each of two randomly selected social studies classrooms at both the 10th- and 11th-grade levels at both schools. In an effort to achieve comparable IQ levels among the groups, only track four classes were sampled at School B. Each subject was administered the Lorge-Thorndike Intelligence Test, Level G, Form 1, and a taxonomic test of the Stages of Economic Development. The latter test was selected from the work of Kropp et al. (1966) on the construction and validation of tests derived from the Taxonomy. Their data clearly support the imputed hierarchical structure of the Taxonomy. Additional cross-validational evidence is supplied by R. B. Smith (1968) and I. L. Smith (1970a). The test consists of six subtests corresponding to the major levels of the Taxonomy. All questions are based on the reading of a passage called The Stages of Economic Development. This material was selected on the basis of interest, ease of comprehension, and most importantly, its unfamiliarity to the students participating in the study. Social studies teachers in both schools examined the passage and concluded that the content was not part of a formal course of instruction nor could it be found in textbooks normally available to the students. Part one of the two-part test consists of the Knowledge, Comprehension, Application, and Analysis subtests, each containing 20 multiple-choice questions. The second part includes five open-ended Synthesis and 10 open-ended Evaluation questions.

The design for the analysis was a two (schools) x two (grades) x two (sex) x two (classrooms nested) analysis of covariance. Since classrooms were randomly selected, the nested factor represented a random dimension. All

other main effects were regarded as fixed. Since performance on tests of the cognitive processes is affected by general aptitude (Smith, 1970a, 1970b, 1971), scores on the Lorge-Thorndike Intelligence Test were employed as a covariate. The analyses were performed using a computer program written by Finn (1968).

Results

The cell means for the taxonomic tests and the Lorge-Thorndike Intelligence Test are presented in Table 2 and the results of the analyses of covariance in Tables 3 and 4.

INSERT TABLES 2, 3, and 4 ABOUT HERE

The results concerning the hypothesis that performance on the first four taxonomic levels favor students from the CT environment is supported only in the case of the Knowledge and Comprehension subtests. Contrary to the hypothesis, no significant differences due to school environment were identified on the Application subtest, while performance on the Analysis level test significantly favored students in the OS climate. As might be expected, the tests of the first four levels appear to be sensitive to developmental differences since 11th-graders performed significantly better than 10th-graders on the Knowledge, Application and Analysis subtests. Sex differences favoring males also appears, but only with respect to the Application level test. The significant School x Sex x Grade interaction on Knowledge indicates that in the OS environment, 10th-grade males performed better than 10th-grade females, but that females surpassed males at the 11th grade. In the CT environment, males surpassed females at both grade levels.

The findings concerning the upper levels of the Taxonomy are supported; performance on the Synthesis and Evaluation sub-tests favors students from the OS climate. While developmental differences again appear, indicating that 11th graders performed significantly better than 10th graders on the Synthesis level test, the Ordinal Grade x Sex interaction suggests the best performance on this subject is demonstrated by 11th grade females. This latter finding is also reflected in the fact that females in general performed significantly better on the Synthesis subtest, while males in general demonstrate significantly better performance on the Evaluation subtest.

In summary, the findings appear to be both confirming and rejecting of the hypotheses. While differences due to school environment appear to be the strongest with respect to the magnitude of the effects, two of the six predicted relationships (Application, Analysis) were not supported. The significant developmental, sex, and interactive effects generally do not appear to exhibit a great deal of strength relative to the effect of school environment. These differences may also be viewed as a function of the particular model (mixed) under which the data were analyzed. If a fixed model analysis of variance had been employed, only the effects of school environment would have been significant. The general findings do indicate that the lower level processes favor students from the CT climate, while the upper level processes favor those from the OS climate. What is apparently needed, then, is a conception of the taxonomic processes that integrates both the positive findings.

Discussion

Appropriate interpretation of the findings requires a consideration of the meaning of the term school environment as it is employed in the present study. Since students were not randomly selected and assigned to school

environments, but identified after designation on this dimension had been made, it is likely that selection factors were operating. For example, application for admission to School A, the OP environment, could not be considered a random process. The testing for admission could also have involved the intentional selection of students on the basis of personality and motivational factors. The IQ scores for these students may have been inflated so as to permit entry. This might explain the discrepancy in performance on the Lorge-Thorndike and WISC. In addition, there is the possibility that the attrition rate was greater for students who found it difficult to work in an unstructured situation as opposed to those who did not. All of these considerations indicate that the question as to whether the OS and CT environments facilitate different cognitive processes cannot be answered with these data. One simply does not know whether the differences identified are a function of school environment, pre-selection factors, non-random attrition rates, or a combination of all of these. The same considerations hold with respect to the hypotheses. While the evidence clearly indicates that the taxonomic tests are sensitive to students in different learning climates, the differences in performance cannot be attributed to the effect of school environment alone, but must include reference to the possiblity of other causal factors. Since these confounding factors probably served to create a greater contrast in the two student populations than would have been expected under conditions of random selection and assignment of students to environments, the difference identified in the present study may be spuriously high.

Within the limits specified above, the mixed nature of the results indicate that the conceptualization of taxonomic levels in terms of covergent and divergent processes is neither supported or rejected. However, it does appear that an alternate interpretation based on the complexity of the processes and their demands for independent-autonomous functioning may provide a more appropriate

explanation of the findings. The complexity hypotheses is the one on which the Taxonomy was originally developed (Bloom, 1956). Given this view, the processes can be classified from simple to complex, specifically based on a dimension demanding increased independent behavior. For example, the less complex processes (Knowledge, Comprehension) require little independent thinking, while the more complex processes (Analysis, Synthesis, Evaluation) require a high degree of independent thinking. This interpretation appears consistent with the findings, since it may be reasonable to assume that School A operates in such a way as to require more independent behavior from its students than School B. The results, then, seem to favorably reflect on the construct validity of the Taxonomy, with the notion of dual processes (convergent-divergent) receiving less support than the complexity hypotheses on which the Taxonomy was originally constructed.

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Table 1

Summary of Differences in

Educational Environment

Criterion	Conventional-Traditional	Open-Spontaneous
Type of Institution	Public	Private
Average Class Sizes	30-45	10-25
Teaching Styles	Formal-Didactic	Informal-Discussion
Extra Class Contact With Teachers, Private Conferences, Informal Chats, etc.	Rare	Frequent
Administrative Control Over Student Time	Present	Absent
Competition	Inter-individual	Intra-individual

Table 2

Cell Means for the Taxonomic Tests and the Lorge-Thorndike IQ Test

	School A				School B			
	Grade 10		Grade 11		Grade 10		Grade 11	
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8
	16.7	16.9	17.0	17.2	18.1	18.7	19.5	19.2
	11.0	10.6	11.2	11.5	13.0	12.2	12.9	13.1
	10.9	11.1	11.4	11.0	11.6	11.5	12.2	11.9
	7.0	7.1	7.6	7.4	6.9	6.7	6.8	6.6
	6.3	6.2	6.4	6.7	5.2	5.1	5.5	5.2
	5.4	5.6	5.6	6.1	2.9	2.8	3.2	3.4
	122.6	119.2	120.3	123.6	121.0	124.2	124.2	120.8
	16.4	16.8	17.3	17.1	18.4	18.2	19.0	18.7
	10.9	10.1	11.1	11.0	12.8	12.4	12.6	13.2
	10.4	10.9	11.3	10.9	11.0	10.9	11.8	11.3
s	6.8	6.8	7.0	7.7	6.2	6.4	6.9	6.9
	6.6	6.8	7.3	7.5	4.9	4.8	5.3	5.3
	4.9	5.0	5.1	5.8	3.0	3.0	3.1	3.5
	121.7	123.6	122.5	124.6	123.4	123.1	122.8	124.6

NOTE - The mean scores for each cell are presented in the following order: Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation, and IQ.

TABLE 3

ANALYSIS OF CO-VARIANCE FOR THE FIRST FOUR LEVELS OF THE TAXONOMY

		KN		CO		AP		AN	
SOURCE	df	MS	F	MS	F	MS	F	MS	F
School (S)[c]	1	103.8	66.3*	95.1	24.1*	12.7	2.2	10.0	4.0*
Grade (G)[a]	1	12.1	17.2*	8.0	2.8	8.9	8.9*	4.0	40.0*
Sex (SE)[b]	1	1.9	4.0	.7	1.4	4.5	43.4*	.5	.7
Classrooms (C)[c] Nested	4	.7	.4	2.9	.8	1.0	.2	.1	.4
S X G[c]	1	.9	1.4	.5	.2	.2	.2	.4	4.1
S X SE[c]	1	.1	.1	2.2	.6	.9	.2	4.3	1.7
G X SE[b]	1	.1	.1	.1	.1	.3	2.9	1.6	2.0
S X G X SE[c]	1	7.3	4.7*	.1	.0	1.4	.2	.4	.2
SE X C[c]	4	.5	.3	.5	.1	.1	.0	.8	.3
Within	143	1.6		3.9		5.8		2.5	

Note: KN, CO, AP, and AN refer to Knowledge, Comprehension, Application, and Analysis, respectively. Values are rounded to the nearest tenth. Estimates of appropriate error mean squares were derived through procedures suggested by Cornfield and Tukey (1956).

*P < .05

[a] Nested factor employed as error term.

[b] Sex X classrooms interaction employed as error term.

[c] Within cell variability employed as error term.

TABLE 4

ANALYSIS OF COVARIANCE FOR THE UPPER TWO LEVELS

OF THE TAXONOMY

SOURCE	df	SY MS	SY F	EV MS	EV F
School (S)[c]	1	120.6	11.9*	248.7	38.1*
Grade (G)[a]	1	5.1	24.7*	3.9	3.5
Sex (SE)[b]	1	.9	30.7*	1.1	13.6*
Classrooms Nested (C)[c]	4	.2	.0	1.1	.2
S X G[c]	1	.0	.0	.2	.0
S X SE[c]	1	4.0	.4	5.5	.8
G X SE[b]	1	.9	34.4*	.0	.0
S X G X SE[c]	1	.3	.0	.6	.1
SE X C[c]	4	.0	.0	.1	.0
Within	143	10.1		6.5	

NOTE. - SY and EV refer to Synthesis and Evaluation, respectively. Values are rounded to the nearest tenth. Estimates of appropriate error mean squares were derived through procedures suggested by Cornfield and Tukey (1956).

*$p < .05$

[a] Nested factor employed as error term.

[b] Sex X Classrooms interaction employed as error term.

[c] Within cell variability employed as error term.